STATE OF CALIFORNIA

AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURES

FOR

AIR QUALITY MONITORING

APPENDIX AJ

RUPPRECHT & PATASHNICK
PARTISOL-FRM MODEL 2000 PM-2.5 AIR SAMPLER

MONITORING AND LABORATORY DIVISION

MAY 1999

TABLE OF CONTENTS

APPENDIX AJ

RUPPRECHT & PATASHNICK
PARTISOL-FRM MODEL 2000 PM-2.5 AIR SAMPLER

TABLE OF CONTENTS (cont.)

APPENDIX AJ

RUPPRECHT & PATASHNICK
PARTISOL-FRM MODEL 2000 PM-2.5 AIR SAMPLER

APPENDIX AJ

RUPPRECHT & PATASHNICK
PARTISOL-FRM MODEL 2000 PM-2.5 AIR SAMPLER

FIGURES

TABLES

STATE OF CALIFORNIA

AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURES

FOR

AIR QUALITY MONITORING

APPENDIX AJ.1

STATION OPERATOR.S PROCEDURES

FOR

RUPPRECHT & PATASHNICK
PARTISOL-FRM MODEL 2000 PM-2.5 AIR SAMPLER

MONITORING AND LABORATORY DIVISION

MAY 1999

AJ.1.0 GENERAL INFORMATION

AJ.1.0.1 PURPOSE

The purpose of these Standard Operating Procedures (SOP) is to supplement the Rupprecht & Patashnick (R&P) Operator's Manual by describing modifications in hardware or operating procedures which may have been implemented by the Monitoring and Laboratory Division of the Air Resources Board (ARB). These modifications are designed to assure compliance with the Federal Reference Method (FRM) for collection of particulate matter 2.5 microns or smaller (PM2.5) when using the R&P Partisol-FRM Model 2000 PM-2.5 Air Sampler. The intent of this document is not to duplicate the R&P manual, and where applicable, this SOP refers to the R&P manual.

AJ.1.0.2 GENERAL DESCRIPTION AND THEORY OF OPERATION

The R&P Model 2000 single channel sampler is designated as a FRM for collection of PM2.5. The sampler's systems perform all the functions required in the instrument specification portion of the PM2.5 FRM standard. The federal standard requires a fixed volumetric flow rate of 16.67 liters / minute (LPM) using a specified PM10 inlet, tubing (downtube), secondary size-selective impactor, filter holder, and filter cassette.

The sampler draws ambient air through its PM10 inlet, PM2.5 Well Impactor Ninety-Six (WINS), and a 47 millimeter (mm) diameter Teflon sample filter, which traps the PM2.5 fraction. The sample filter is conditioned and weighed before and after sampling. The resulting difference in weight is the collected PM2.5 mass in micrograms (µg). Electronic systems in the sampler are designed to monitor and maintain the volumetric flow rate as well as record the elapsed sampling time enabling the R&P Model 2000 to calculate the total sample volume in cubic meters (m^3). With this information, the analyzing laboratory will calculate and report the average PM2.5 concentration for the sampling period in $\mu g/m^3$.

The R&P single channel sampler monitors and regulates the flow rate using the sampler's microprocessor, software, mass flow controller, ambient temperature sensor, and ambient pressure sensor. The sampling period must be between 1380 and 1500 minutes. The flow rate of the sampler must be 16.67 LPM +/- 5%. Federal regulations require the data completeness to be greater than 75 percent.

For a more detailed explanation of the sampler's theory of operation, please read Section 1: Introduction, of the Operator's Manual and see Figure AJ.1.0.1: Schematic of R&P Model 2000 PM2.5 Single Channel Air Sampler and Figure AJ.1.0.2: Schematic of the WINS Impactor.

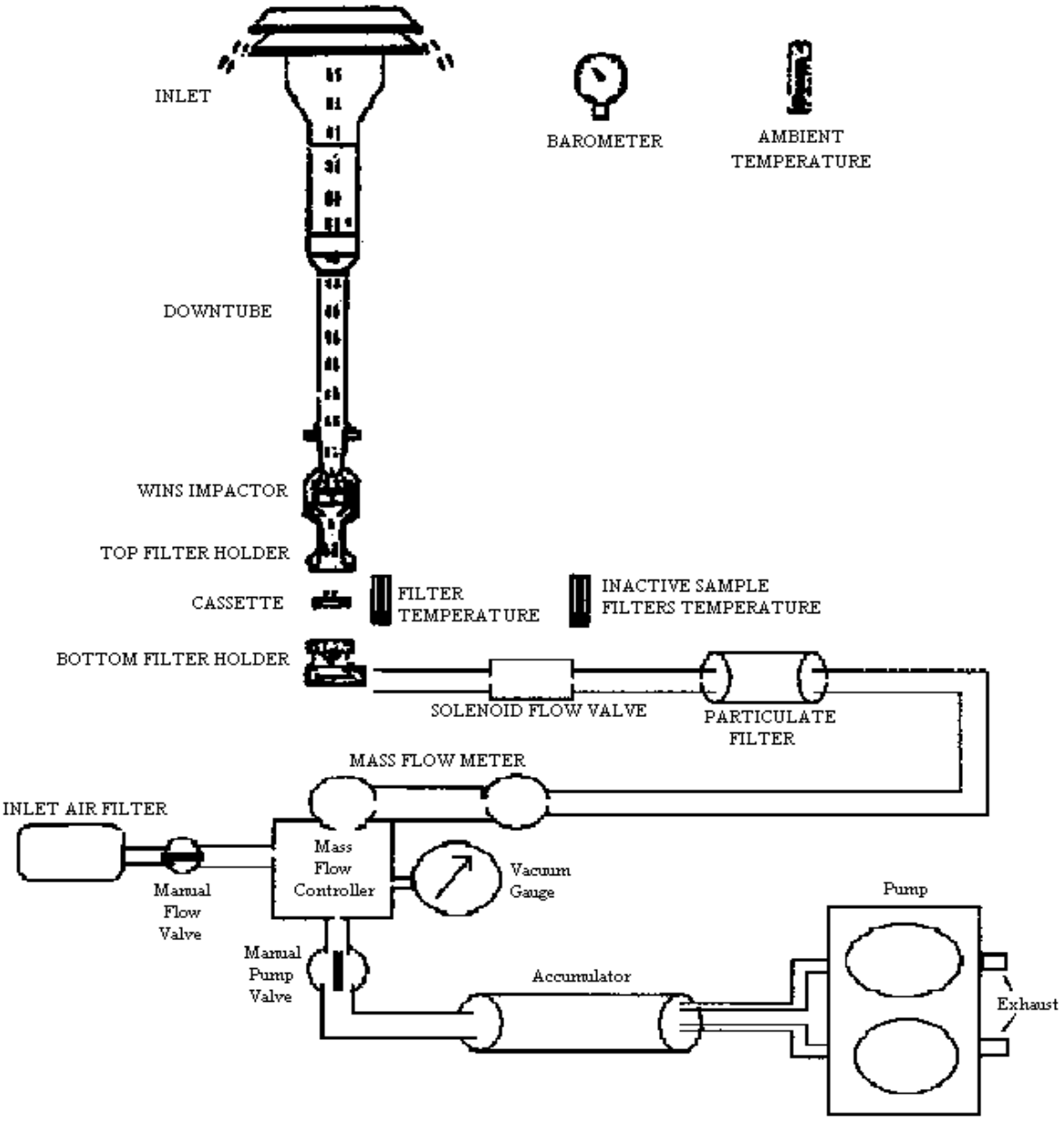

Figure AJ.1.0.1
Schematic of R&P Model 2000 PM2.5 Single Channel Air Sampler

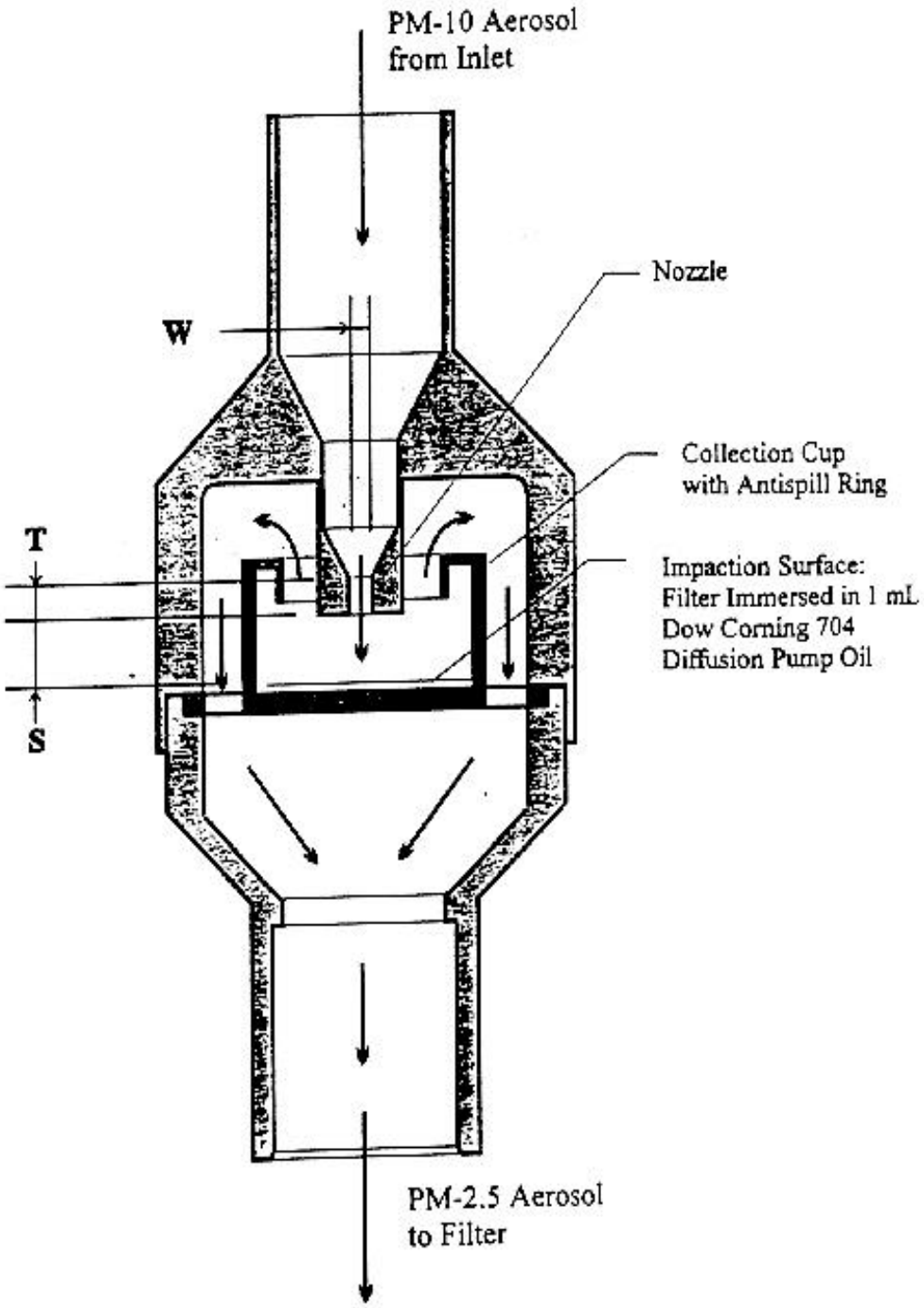

Figure AJ.1.0.2
Schematic of the WINS Impactor

AJ.1.0.3 SAFETY

Think "safety first". High (120 volts AC) voltages are used to power the unit. Watch where and how you place your hands in the sampler. Unplug the sampler whenever possible while working around electrical components. Working outdoors in ambient (wet) weather conditions increases the risk of electrocution.

Consult the Material Safety Datasheets (MSDS) for safety information about silicon oil, halocarbon grease, and other materials that may be used to clean the R&P sampler parts.

Rooftop sampling creates a hazard of falling. Be careful climbing and descending to and from the rooftop platform. For additional safety information, read Section 2.2.5: Hardware Installation and Maintenance of the R&P Operating Manual and the Air Quality Surveillance Branch Safety Manual.

AJ.1.0.4 SOFTWARE SETUP FOR ARB OPERATION

AJ.1.0.4.1 CURRENT TIME

Figure AJ.1.0.3 presents diagrams of the R&P keypad and a hierarchy of screens which can be viewed from the sampler's display screen. From the "Main Screen" ensure the sampler is in the "STOP" operating mode. Then hit **Setup (F5),** and cursor to the "Current Time". Hit **Edit (F1)** and set the current time.

NOTE: As with all ARB samplers, current time is set to PST.

AJ.1.0.4.2 START TIME

Use the arrow keys to cursor over to the "Start Time". Enter as **0.00**.

AJ.1.0.4.3 DATE

Use the arrow keys to cursor over to the "Current Date".
Enter the current date as: **YY/MM/DD**

AJ.1.0.4.4 DURATION

Use the arrow keys to cursor over to the default "Duration".
Set the duration to **24.00** hours.

AJ.1.0.4.5 FLOW RATE

Arrow over to "Set Flow", and set the flow rate to **16.7** LPM.

AJ.1.0.4.6 SERIAL NUMBER

Arrow down and over to enter in the last 4 digits (**XXXX**) of the ARB bar code number on the sampler into the "serial number" cell. To save all set-up parameters, hit the **ENTER** touchkey.

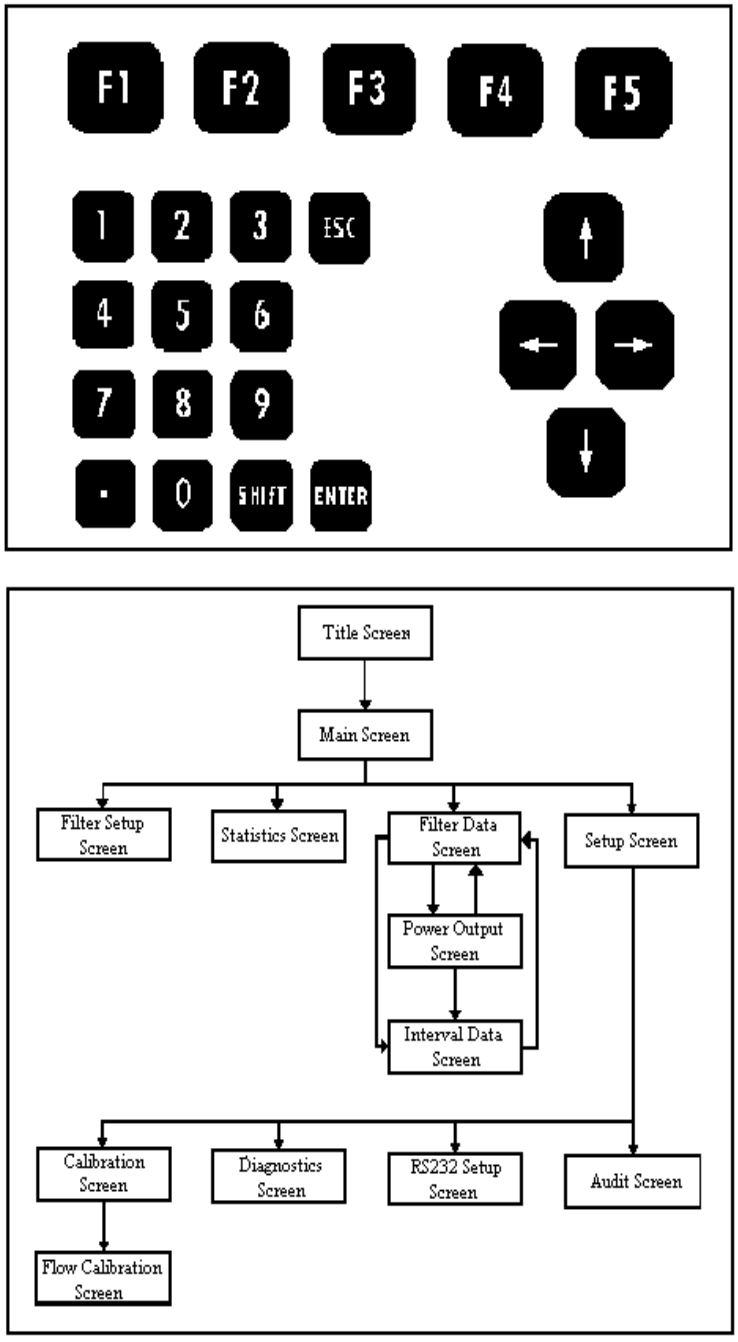

Figure AJ.1.0.3
R&P Keypad Hierarchy of Screens

AJ.1.1 INSTALLATION PROCEDURE

AJ.1.1.1 PHYSICAL INSPECTION

Each R&P Partisol-FRM Model 2000 PM-2.5 Air Sampler purchased through the National PM2.5 Sampler Procurement Contract should be supplied with the following supplies:

1 Partisol-FRM enclosure with WINS PM-2.5 impactor and filter exchange mechanism
1 1st stage PM10 Inlet
1 sample tube
3 rain hoods and associated hardware
1 flow audit adapter
1 dual filter transport container with cassettes and carriers
1 ambient temperature sensor and cable
3 sets of impactor wells and anti-spill rings
4 sets of filter cassettes and backing screens
2 sets of inlet O-rings
1 bottle (100 milliliters (ml)) of WINS impactor oil
1 box (50 count) of glass fiber impactor filters, 37 millimeter (mm)
1 analog input calibration cable
1 mating cable connector for four-pin user output connector
1 AKCOMM software diskette
1 9-to-9 pin computer cable
2 Operating Manuals
1 Service Manual
1 Quick Start Guide

Upon receipt of the sampler(s), inspect sampler and accessories for shortage and for shipping damage. If shortage or damage is found, immediately notify your supervisor and/or your agency's shipping department.

AJ.1.1.2 INITIAL SAMPLER INSTALLATION

Follow directions found in Section 2 of the R&P Operating Manual for installation instructions and consult with your area specialist/engineer or supervisor to assure that installation site complies with Federal and State siting criteria for FRM PM2.5.

AJ.1.1.3 INITIAL SAMPLER SET-UP

Follow directions found in Sections 4, 5, and 6 of the R&P Operating Manual.

AJ.1.2 SAMPLER FILTER HANDLING PROCEDURES

AJ.1.2.1 OVERVIEW

These PM2.5 samplers will operate on a 3- or 6-day schedule. The 6-day operating schedule is shown as Table AJ.1.2.1. Field operators are required to use care in handling the samples so that the filters arrive in the laboratory with the same mass that was collected at the end of the sample run. The operators must not contaminate the filters with fugitive particulate matter, and must not lose mass from the filters by allowing particles to shake loose from the filter or heat the filters and drive off heat sensitive particulate matter. The operator must accurately and completely fill in the 24-Hour Field Sample Report (Figure AJ.1.2.1) associated with each filter. Finally, the field operator must send the filter to the laboratory within the appropriate time and temperature constraints.

AJ.1.2.2 FIELD FILTER PREPARATION

The filter cassette assembly should be kept in its protective container until installation. Never remove the filter from the cassette. In the field office or a dust-free work environment, place an unsampled filter cassette into a filter cassette holder. Perform this by removing the metal cassette cover from the bottom of the cassette. Snap the cassette into the cassette holder, leaving the top cassette cover in place to protect the filter until installation into the sampler. Take the removed metal cassette cover along with you to the sampler. Place the filter cassette holder into a filter cassette transport container.

Fill in the 24-Hour Field Sample Report. Include the site name, site AIRS number, technician name, agency, cassette ID#, scheduled sampling date and sampler property number. Take the filter, 24-Hour Field Sample Report, and Monthly Maintenance Checksheet (Figure AJ.1.2.2) to the field sampling location.

AJ.1.2.3 REMOVAL OF PREVIOUS FILTER

The sample must be removed from the R&P sampler within 96 hours (4 days) of the end of the run. Open the door of the sampler and observe the status of the previous sample run. In the upper left hand corner "STAT" should indicate "OK". If there was an occurrence of any status condition, its code should be displayed (reference the 24-Hour Field Sample Report and/or Section 6 of the R&P Operating Manual). Observe the sampler mode condition. If the sampler has completed a sample run, the condition should indicate "DONE", unless an error condition ("ERR") was encountered during the sampler run. Hit the **Run/Stop (F4)** touch key, and the sampler should go to "STOP" mode.

NOTE: Always exchange filter cassettes with the sampler in the "STOP" mode.

Hit the **Data (F3)** touchkey. Observe and record the start time/date, total elapsed time, sample volume, and flow %CV. Next, observe and record the minimum, average, and maximum ambient temperature, filter temperature, and pressure. Also record the average flow results. Record the local condition code. Hit the **Pwr Data (F4)** touchkey to view and record any power interruption messages. Hit the **ESC** touchkey twice to return to the Main Screen. Record the date and time of filter removal from the sampler in the Chain-of-Custody section of the 24-Hour Field Sample Report.

Pull the handle of the filter exchange mechanism out to access the sampled filter. Visually check the filter while in the cassette for tears, pinholes, or any unusual appearance. Immediately install a metal cassette cover on the top of the filter cassette. Remove the filter holder with cassette from the sampler and place it into the filter transport container. Do not allow the filters to be shaken, dropped, or touched by any foreign object. Check the sampler for any obvious problems, such as a full water jar. Describe any obvious sampler problems on the monthly maintenance checksheet, and take corrective action before the next sample run. Note any anomalies on the 24-Hour Field Sample Report.

AJ.1.2.4 REQUIRED MAINTENANCE

Complete the Monthly Maintenance Checksheet and perform all required maintenance actions. Annotate the Monthly Maintenance Checksheet accordingly. Refer to the Maintenance Section (AJ.1.3).

AJ.1.2.5 LOADING NEW FILTER

Take the unsampled filter cassette from the filter cassette transport container and remove the top metal cassette cover from the filter cassette. Place the cassette holder in position to collect a sample. Ensure the cassette holder is seated properly on the alignment pins. Push the handle of the filter exchange mechanism inward to lock the new filter cassette into place, being careful to ensure good alignment of the upper and lower cassette seals.

AJ.1.2.6 PROGRAM THE SAMPLER FOR THE NEXT RUN

From the Main Screen, hit the **Filter Set (F1)** touchkey to reprogram for the new start and stop days. Hitting the **Next Day (F3)** touchkey will advance the program to the next day and default start time. Then hit the **+Day (F4)** touchkey until the correct scheduled start date is indicated. The start time/end time should not require adjustment, unless you are changing it from the default values.

Use the arrow keys to cursor down to "ID1". Hit the **Edit (F1)** touchkey, and enter the barcode number of the new sample taken from the top of the 24-Hour Field Sample Report. Hit **Enter** to program that number into the sampler's memory. Hit Escape (**ESC**) to return to the Main Screen. Ensure that the new programmed scheduled start date/time is indicated.

Hit **Run/Stop (F4)** to put the sampler in the "Wait" mode. You should also see "0.0 Flow Rate", "0.0 Volume", and "000.00 Sample Time".

AJ.1.2.7 POST-SAMPLING PROCEDURE

Back in the field office or a dust-free work environment, carefully remove the sampled filter from the filter holder and place a metal cassette cover on the bottom of the filter cassette. Place the sampled filter in a cold shipping cylinder. Remove the tabs and place a set of 5^{o} and 25^{o} heat sensing strips inside the shipping cylinder. Document the date and time the samples are placed in the cooler or shipped to the laboratory on the 24-Hour Field Sample Report. Note any problems in the comment section of the 24-Hour Field Sample Report as well as on the Monthly QC Checksheet. Complete the information in the Chain-of-Custody section of the 24-Hour Field Sample Report, place the report inside a zip-lock plastic bag to avoid condensation damage and attach the bag to the exterior of the shipping cylinder with a rubber-band. Place the shipping cylinder into the freezer or ship the cylinders as required.

AJ.1.2.8 INTRODUCTION TO DATA SUBMITTAL

Once field personnel have retrieved sampling information either manually (off the sampler's display as described in AJ.1.2.3) or electronically, the sample run information must be forwarded to the laboratory. If the sampling information was recorded manually, a 24-Hour Field Sample Report(s) will accompany the sampled filter(s) to the laboratory. If the sampling information was recorded electronically, the sampling information will be sent to the lab via file transfer protocol and an abbreviated 24-hour sample record, and additional sampling information will accompany the sampled filter(s) on the 24-Hour Field Sample Report.

AJ.1.2.9 ELECTRONIC DATA SUBMITTAL TO LABORATORY

(*work in progress)*

AJ.1.2.10 ADDITIONAL FILTER HANDLING AND SHIPPING INFORMATION

Some of the major differences between collection of PM2.5 using the new Federal Reference Method (FRM) and the older dichot filter sampling for particulates are the additional time and temperature requirements (see *Filter Holding Times* presented in Table AJ.1.2.2). The new FRM PM2.5 filters must be used for sampling within 30 days of the date of preweighing by the laboratory. Also, postweighing by the laboratory must be performed within ten (10) days of the end of the sampling if the sampled filters have been continuously stored at no more than 25°C since removal from the sampler. If the sampled filters have been continuously stored at 4°C or less since removal from the sampler, the laboratory can conduct postweighing within 30 days of the end of sampling.

Since this latter (30 days at $\leq$4°C) requirement is preferred to give sufficient time for field, transport, and laboratory operations, additional equipment such as a freezer, insulated shipping containers, and chilled medium ("Blue Ice" or equivalent), will be provided to the field operators to meet the sample filter holding requirements. The shipping cylinders can be stored with previously received cylinders in the freezer. Store them in such a way that the first received is the first sampled, and the first sampled is the first shipped.

To minimize the possibility of contaminating the sample filter prior to the sampling event, load the sample filter(s) at a time as close as practical to the start of the sampling event. Although the sample cassette(s) may remain in the sampler up to 96 hours (4 days) after the end of the sampling event, remove them from the sampler as soon as practical.

When traveling to a satellite PM2.5 site, the operator should bring a chilled shipping cylinder and cooler having chilled medium inside. The shipping cylinder will be used to chill the sampled filters to less than 4°C during the transportation period to the operator's field office or shipping location. If during shipment a temperature threshold is exceeded, note this information in the affected sample filter's 24-Hour Field Sample Report.

Prepare the filter samples for shipment. Remove the shipping cylinder(s) containing the oldest (earliest sample date) sample cassettes and attached 24-Hour Field Sample Reports from the freezer. Open the shipping cylinder and confirm that each sample cassette has a matching sample report. Orient the indicators in such a manner that the indicator window is clearly visible upon examination. Fill-in the appropriate portions of each Chain-of-Custody (located on the 24-Hour Field Sample Report) at this time. Close the shipping cylinder(s). Next, place the shipping cylinder with its report in an insulated shipping container. The type of insulated shipping container needed and the amount of chilled medium used will depend on the transit time of shipping as well as the expected ambient temperatures during

shipment. Close the shipping container and secure the lid or opening to prevent opening during shipment. Address the container to the analyzing laboratory and store the container in a cool place until pickup.

For sampling locations outside of a reasonable driving distance to the analytical laboratory, shipments to the laboratory will be made on a weekly basis using UPS Ground Service or other suitable service or carrier. Determine beforehand how long the transit time is between pick-up and arrival at the laboratory. Schedule the pick-up early enough in the week to avoid arrival on weekend or holiday dates.

AJ.1.2.11 TRIP BLANKS

Trip blank filters in cassettes and protected by metal cassette covers will be shipped to each site on a monthly basis. The metal cassette covers will remain on the trip blank filters and the trip blank filters will be left in the shipping cylinder. Record the relevant trip information for the trip blank on its Chain-of-Custody Report.

AJ.1.2.12 FIELD BLANKS

Field blanks will be shipped to each site on a monthly basis. The field blanks will be taken from the shipping canister and placed in the filter transport container. The regular sampling filter and the field trip blank will be taken to the location of the sampler. The previous sampled filter will be removed and placed in the filter transport container. The new field blank filter will be loaded into the sampler and remain there for approximately one minute. The field blank filter will then be removed, capped with the metal covers, and the field blank filter will be placed in the filter transport container. The date, time, and length of filter exposure will be recorded on the Chain-of-Custody Report form for the field blank.

AJ.1.2.13 TROUBLESHOOTING

If a problem is encountered as a result of the review of the sample summary data, which may affect the validity of the sample, download and store the five-minute averages. Review the five-minute averages for operational parameters, which may exceed limits of measurement quality objectives defined in Table AJ.1.0.2 of these procedures. Also refer to Section 11: Resetting the Sampler for a probable cause and remedy. Notify your supervisor or area calibrator if the problem cannot be resolved. If the perceived problem does not affect sample validity, continue to monitor the problem or correct it. If the problem persists, contact the ARB shop repair specialist or Rupprecht & Patashnick Co. at (518) 452-0065.

1999 SAMPLING SCHEDULE

Dichot, PM10, PM2.5, Dry Dep

January

S	M	T	W	T	F	S
					1	2
3	4	5	(6)	7	8	9
10	11	(12)	13	14	15	16
17	(18)	19	20	21	22	23
(24)	25	26	27	28	29	(30)
31						

February

S	M	T	W	T	F	S
	1	2	3	4	(5)	6
7	8	9	10	(11)	12	13
14	15	16	(17)	18	19	20
21	22	(23)	24	25	26	27
28						

March

S	M	T	W	T	F	S
	(1)	2	3	4	5	6
(7)	8	9	10	11	12	(13)
14	15	16	17	18	(19)	20
21	22	23	24	(25)	26	27
28	29	30	(31)			

April

S	M	T	W	T	F	S
				1	2	3
4	5	(6)	7	8	9	10
11	(12)	13	14	15	16	17
(18)	19	20	21	22	23	(24)
25	26	27	28	29	(30)	

May

S	M	T	W	T	F	S
						1
2	3	4	5	(6)	7	8
9	10	11	(12)	13	14	15
16	17	(18)	19	20	21	22
23	(24)	25	26	27	28	29
(30)	31					

June

S	M	T	W	T	F	S
		1	2	3	4	(5)
6	7	8	9	10	(11)	12
13	14	15	16	(17)	18	19
20	21	22	(23)	24	25	26
27	28	(29)	30			

July

S	M	T	W	T	F	S
				1	2	3
4	(5)	6	7	8	9	10
(11)	12	13	14	15	16	(17)
18	19	20	21	22	(23)	24
25	26	27	28	(29)	30	31

August

S	M	T	W	T	F	S
1	2	3	(4)	5	6	7
8	9	(10)	11	12	13	14
15	(16)	17	18	19	20	21
(22)	23	24	25	26	27	(28)
29	30	31				

September

S	M	T	W	T	F	S
			1	2	(3)	4
5	6	7	8	(9)	10	11
12	13	14	(15)	16	17	18
19	20	(21)	22	23	24	25
26	(27)	28	29	30		

October

S	M	T	W	T	F	S
					1	2
(3)	4	5	6	7	8	(9)
10	11	12	13	14	(15)	16
17	18	19	20	(21)	22	23
24	25	26	(27)	28	29	30
31						

November

S	M	T	W	T	F	S
	1	(2)	3	4	5	6
7	(8)	9	10	11	12	13
(14)	15	16	17	18	19	(20)
21	22	23	24	25	(26)	27
28	29	30				

December

S	M	T	W	T	F	S
			1	(2)	3	4
5	6	7	(8)	9	10	11
12	13	(14)	15	16	17	18
19	(20)	21	22	23	24	25
(26)	27	28	29	30	31	

Table AJ.1.2.1
6-Day Sampling Schedule

CARB 24-Hour - FIELD SAMPLE REPORT
Rupprecht and Patashnick FRM Model 2000 PM2.5 Sampler

Bar Code:

LIMS Sample ID:

Site Name: _____ Cassette I. D. Number: _____
AIRS Site Number: _____ Scheduled Sampling Date: _____
Field Technician: _____ Sampler Property #: _____
Agency: _____

SAMPLE SUMMARY

☐ Check if data electronically submitted to Laboratory

Start Date / Time: _____ /
Total Elapsed Time: _____ Hr:min
Volume: _____ M^3
Flow CV: _____ %

	MIN	AVG	MAX
Ambient Temp (C):			
Filter Temp (C):			
Pressure (mmHg):			
Flow :			

Local Condition Codes: _____ Sampler Flag Codes: _____

A.	No Unusual Conditions	E.	Fire Nearby
B.	Wind/Blown Sand/Dust	F.	Sampler Malfunction
C.	Construction Nearby	G.	Rain
D.	Farming Operation Nearby	H.	Other (See Comments)

OK	Good	T.	Filter Temp.
F.	Flow Rate	I.	Inst. Elec. Temp
X.	Flow Cutoff	V.	Power Outage
S.	Ambient Temp.	E.	Elapsed Sample Time
P.	Ambient Pressure	C.	Percent CV

Operator Comments: _____

Chain of Custody

ACTION	DATE	TIME	FILTER TEMP. (C)	NAME
Sample Load				
Sample Removal				
Sample placed in cooler				
Sample shipped **to** Lab				
Sample received **at** Lab				
Start post-conditioning				

FOR LABORATORY USE ONLY

Postweigh by: _____

	Mass:	Dup Mass:	Date:	Analyst:
Preweight				
Postweight				

Lab Comments: _____

Figure AJ.1.2.1
CARB 24-Hour Field Sample Report

CARB MONTHLY QUALITY CONTROL MAINTENANCE CHECK SHEET
R&P Partisol – FRM Model 2000 PM-2.5 AIR SAMPLER
SINGLE CHANNEL

Site Name _____ Month/Year _____
Site Number _____ Technician _____
Sampler I.D. Number _____ Agency _____

Operator Instructions:

Each Run: **Record and review sample run date; inspect/clean water jar, cassette & rubber seals.**
Run Dates: _____ _____ _____ _____ _____ _____ _____ _____ _____

Every 5 Runs: **Clean or change out WINS impactor well.**
Dates WINS Serviced: _____ _____ _____ _____ _____ _____

Monthly: **Clean interior of sampler, air intake filter and fan. Date Performed:** _____
Inspect o-rings, gaskets, seals; check sampler clock time (<+/-10 min): _____
Perform single-point QC check of flow rate, ambient temperature and pressure. * (annotate below)
Run field and trip blanks, and temp-logger with samples during transport. Date: _____
Perform leak check –Date/Results: ___/___ _____/_____ _____/_____
(<80mL/min for 1 min.: which is equal to <5" Hg change/min.)

Every 14 Runs: **Disassemble and clean PM10 Inlet, downtube and entire WINS.**

Semiannually: **Perform multi-point calibration of flow rate, temperature, and pressure sensors.**
Date Last Calibrated: _____
Perform Leak Test, Inspect sampler's inlet, WINS, and interior conditions.
Replace large in-line filter. Date Last Performed: _____
Check Voltage Level on Main Computer Board Battery. Date Last Performed: _____
Measure temperature of station freezer. Date Last Performed: _____

Annually: **Re-certify QC check standards – Certification Date:** _____ _____ _____
(flow std) (temp std) (press std)

***Monthly Sampler Flow Rate, Ambient Temp and Pressure Check Results:**

	Flow Rate Standard	Temperature Standard	Pressure Standard
Standard Name/Type:			
Identification Number:			
Correction Factor:			
Std's Indicated Readings:			
Std's Corrected Readings:			
Sampler's Reading:			
Percent Difference:			
Acceptance Criteria:	**15.84 to 17.50**	**≤+/-2°C of standard**	**≤+/-10 mm Hg of std**

Operator Comments: _____

MLD-XXX (3/99) **Reviewed by:** _____ **Date:** _____

Figure AJ.1.0.5
Monthly Quality Control Maintenance Check Sheet

Requirement	Frequency	Acceptance Criteria
Filter Holding Times: Pre-sampling Post-sampling (in sampler) Post-sampling (during storage and transport)	All sample filters	<30 days after preweighing <96 hrs from end of sampling <10 days at 25°C from end of sampling or <30 days at 4°C from end of sampling
Sampling Period:	all data	1380 to 1500 minutes or MC if <1380 and exceedance of NAAQS
Sampler: Flow rate Flow rate variability Filter temp sensor	Every 24 hrs of operation	±5% of 16.67 LPM ≤2% CV measured ≤5% average for 5 min ≤5°C of amb temp for <10 min
Data Completeness:	quarterly	75%
Filter:	all filters	Visual defect check
Monthly QC Check: Flow rate Leak check Ambient temp sensor Ambient press sensor Clock/timer	monthly	±5% of standard <5 inches Hg pd in 1 minute +/-2°C of standard +/-10 mm Hg of standard +/-10 min of corrected clock time
Multi point Calibration: Flow rate Leak check Temperature sensors Pressure sensors	semiannually or when failed monthly check, following major repair, or after sampler transport	+/-2% of transfer (xfer) standard <5 inches Hg pd in 1 minute +/-2°C of xfer standard +/-10 mm Hg of xfer standard
Monthly QC Standards: Flow rate standard Temperature standard Pressure standard	annually	+/-2% of Full Scale @ 20 LPM +/-0.1°C resolution +/-0.5°C accuracy +/-1 mm Hg resolution +/-5 mm Hg accuracy
Calib. Xfer Standards: Flow rate xfer standard Temperature xfer standard Pressure xfer standard	FTS meter annually Mass flow meter quarterly annually annually	+/-2% of NIST-traceable standard +/-0.1°C resolution +/-0.5°C accuracy +/-1 mm Hg resolution +/-5 mm Hg accuracy

Table AJ.1.2.2
Measurement Quality Objectives for FRM PM2.5

AJ.1.3 QUALITY CONTROL MAINTENANCE PROCEDURES

AJ.1.3.1 GENERAL INFORMATION

Quality Control (QC) maintenance procedures (checks) are designed to help assure that valid data is produced as a result of proper sampler operation and maintenance in accordance with its federal designation and the manufacturer.s operating manual. The maintenance frequency presented in these standard operating procedures should be considered the minimum required even though the actual frequency of performing some of these checks may vary from site to site due to different environmental factors. These may include the sampling schedule, particulate concentrations, or seasonal factors, which may require an increase in maintenance frequency. In the event that these checks cannot be performed on schedule, the deferred maintenance should be performed as soon as practical. The QC procedures schedule is presented in Table AJ.1.3.1.

When QC checks are performed, the date, results, and any pertinent comments should be recorded onto the Monthly Quality Control Maintenance Checksheet for the FRM PM2.5 Filter Sampler (QC Checksheet) presented in Figure AJ.1.2.2. This document will be forwarded to the supervisor on a monthly basis for subsequent review and filing. It is recommended that a copy be made by the operator and kept at the field site for later reference by the operator or a site visitor. Maintenance of the R&P sampler is discussed in Section 9.1 of the R&P manual.

AJ.1.3.2 CHECKS AFTER EACH RUN

Review the summary data for reasonableness and for compliance with Measurement Quality Objectives for FRM PM2.5 presented in Table AJ.1.2.2. If questionable summary data is seen, download the five-minute data averages using the AKCOMM software and a laptop (PC) and examine these averages for anomalies. Procedures for downloading these data are presented in Section AJ.1.2.8 of this SOP as well as Appendix D of the R&P manual. In the event that anomalies are present in the five-minute averages, troubleshoot the sampler according to instructions in Section 11 or the Appendices of the R&P manual and notify your supervisor. During the procedure of unloading the sample cassettes from the sampler, record the sample summary data onto the sample cassette.s matching 24-Hour Field Sample Report. Also, record run date on the QC Checksheet.

Keep the filter cassettes clean. Wipe with a clean dry cloth as required. Examine the upper and lower rubber cassette seals and replace if they are cracked or damaged. Keep the rubber seals clean. Also, visually inspect the PM10 inlet’s water collector jar and drain it if water is present.

Quality Control Maintenance Schedule for
Federal Reference Method PM2.5 Sampling

	*Daily	Every 5 Samples	Every Month	Every 14 Samples	Every 6 Months	Every 12 Months
Record and Review Run Data Summary	X					
Clean/Inspect Cassette & Rubber Seals	X					
Inspect or Drain Inlet Water Jar	X					
Service WINS Impactor Well		X				
Perform a Leak Test		X	X			
Clean Interior of Sampler			X			
Clean Air Intake Filter and Fan			X			
Inspect O-rings, Gaskets and Seals			X			
Verify Sampler Clock Time			X			
Perform Single-Point Flow Check			X			
Check Ambient Temp and Press Sensors			X			
Run Field and Trip Blanks			X			
Transport Samples with a Temp-Logger			X			
Disassemble and Clean PM10 Inlet, Downtube and Entire WINS				X		
Perform As-Is Three Point Calibration /Verification of Flow Rate, Pressure and Temperature Sensors					X	
Verify As-Is Condition of Sampler.s Interior, Inlet, WINS Impactor & Leak Test					X	
Replace Large In-line Filter					X	
Check Battery on Main Computer Board					X	
Perform Multi-point Calibration of Flow Rate, Pressure & Temperature Sensors					X	
Measure Temp of Station Freezer					X	
Calibrate or Re-certify Flow rate, Press and Temp QC Check Standards						X

*or each time sample cassettes are exchanged

Table AJ.1.3.1
QC Maintenance Schedule for FRM PM2.5 Sampling

AJ.1.3.3 CHECKS EVERY FIVE SAMPLING RUNS

Remove the WINS impactor from the sampler and inspect impaction well to determine size of particulate cone, which may have formed in the center of the well. A cone taller than two (2) millimeters or a cone with its top broken off indicates a need for more frequent well cleaning to minimize the possibility of particle bounce and re-entrainment of particles larger than 2.5 microns.

Clean or replace impactor well with a newly serviced well. Refer to the procedures in Appendix H.2 of the R&P manual for instructions on servicing the impactor. Record performance of this procedure and pertinent comments onto the sampler's QC Checksheet.

After servicing the WINS impactor and reinstalling, perform a leak test and record the results on the sampler's QC Checksheet. If the results of the leak check do not meet the criteria, investigate and repair the source of the leak.

AJ.1.3.4 MONTHLY CHECKS

Clean the interior of the sampler chassis with a damp cloth. Remove the air intake filter and clean it with soap and water. Clean air intake fan blades with a damp cloth or brush if necessary. Inspect the sampler o-rings and gaskets.

Verify that the sampler's clock time is within ten (10) minutes of standard time as compared to a clock standard such as the telephone service time or WWVB time in Fort Collins, CO. If there is a difference of more than 10 minutes, reset the sampler's clock to within one (1) minute of the standard according to instructions given in Section 4.3 of the R&P manual. Record the date that these procedures were performed and the results obtained onto the sampler's QC Checksheet.

Perform the single-point flow check using an actual flow rate or volume measuring device having an accuracy of at least +/-2 percent (%) of full scale (0-20 LPM vol-o-flow, mass flow meter, etc.) and which is calibrated or certified annually against a NIST-traceable standard. If the sampler's flow rate measurement is not within +/-5% of the standard's measurement, investigate the cause. If a cause for the flow discrepancy cannot be found, notify your supervisor or area calibrator. Record the date that these procedures were performed and results of the single-point flow check onto the sampler's QC Checksheet.

Perform a single-point check of ambient pressure and ambient temperature sensors using a temperature and pressure standard which is calibrated or certified annually against a NIST-traceable standard. Ensure the sampler's measurements are within the

acceptance criteria, (+/-4% for flow rate, <80 mL/min for leak check, ±10 mm Hg for pressure, and ±2°C for temperature).

Trip blanks and field blanks will be initiated by the laboratory. The laboratory will designate a sample cassette as a trip blank or a field blank. The operator will treat this sample cassette in the same manner as a regular sample cassette used for sampling with the sole exception that it will not be used to collect a sample. The field blank sample cassette is to be loaded and unloaded from the sampler, transported, stored and shipped as usual, but the sampler will not be programmed for a sampling event using this sample cassette. Perform a leak check of the sampler to ensure that a leak has not been introduced by the previous procedures.

AJ.1.3.5 CHECKS EVERY 14 SAMPLING RUNS

Disassemble and clean the PM10 inlet, sampler downtube, and the entire WINS impactor assembly. Inspect o-rings for abrasions, breaks, tears, deformations or other damage. If necessary, replace o-rings and lubricate them with a light coating of halocarbon or silicone vacuum grease prior to reassembly. Using the same lubricant, also lightly lubricate any aluminum threads and take extra care that the fine threads are not cross-threaded during assembly. Appendix H.1 of the R&P manual discusses the procedure for maintenance of the PM10 inlet. After reassembly, perform a leak check according to instructions in Sections 10.2.4 and 10.2.5 of the R&P manual and record the results on the QC Checksheet. Ensure the results of the leak check comply with the quality assurance criteria found in Table AJ.1.2.2.

AJ.1.3.6 SEMIANNUAL CHECKS

Every six (6) months, the area calibrator will inspect the sampler.s interior, PM10 inlet, and WINS impactor, for cleanliness and condition, after an as-is calibration verification check for temperature, pressure, and flow has been performed. If any of the sampler.s calibrated systems fail to meet the measurement quality objectives presented in Table AJ.1.2.2, the calibrator must adjust the parameter to bring it within specification. The operator may assist the area calibrator in performing all necessary repairs and maintenance prior to the calibrator performing a final multi-point calibration on the system that failed. See Section AJ.2.0 for calibration procedures.

Replace the large in-line filter. It is recommended that the sampler be turned off for this procedure.

Check the voltage level of the main computer board’s battery. See Appendix F.1 of the R&P manual for details.

Measure the temperature of the station freezer

AJ.1.3.7 ANNUAL CHECKS

The operator will have their flow rate, temperature, and pressure QC verification check measurement standards re-certified or calibrated against a NIST-traceable standard. The date that these procedures are performed will be recorded onto the sampler's QC Checksheet.

STATE OF CALIFORNIA

AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURES

FOR

AIR QUALITY MONITORING

APPENDIX AJ.2

CALIBRATION PROCEDURES FOR R&P PARTISOL-FRM MODEL 2000 PM-2.5 AIR SAMPLER

MONITORING AND LABORATORY DIVISION

MAY 1999

AJ.2.0 BACKGROUND AND GENERAL INFORMATION

AJ.2.0.1 INTRODUCTION

The following procedures describe the techniques used to verify and calibrate the Rupprecht & Patashnick Partisol - FRM Model 2000 PM-2.5 single channel air sampler (R&P 2000). Due to our limited exposure with this sampler in the field, this document is a working procedure and is intended to be revised as we gather more experience and information. The purpose of this written procedure is to outline the techniques that the ARB will be using to calibrate the volumetric flow of the R&P 2000 sampler at 16.7 liters per minute (a volume of 1 cubic meter of air per hour) as referenced in 40 CFR Part 50, Appendix L. The calibration procedures listed in the R&P manual (Section 11) are fairly straight forward with all the necessary information and diagrams included. This procedure will attempt to clarify anomalies in the R&P manual in a step-by-step calibration format.

Through the normal course of operation, there may exist circumstances in which the sampler will need to be reset. If this occurs, span and offset values may need to be reentered. Keeping an accurate and handy record of the verification and calibration values (Figure AJ.2.0.1) can help avoid performing a full calibration after resetting the sampler.

Verification techniques are included with the following calibration procedures. When performing routine calibrations at the six-month intervals, the verification steps concerning ambient temperature, filter temperature, ambient pressure and flow are crucial and must be followed.

AJ.2.0.2 OVERVIEW

The R&P 2000 is a new generation filter sampler that is required to control a volumetric flow, and to monitor the temperature of the exposed filter while still in the sampling position. To perform these tasks, the sampler uses an ambient temperature sensor (AmbT), a filter temperature sensor (FltT), a pressure sensor (Pres) and a mass flow controller (MFC). These sensors and MFC require calibration when the sampler is installed/replaced and require verification/calibration every six months or sooner if necessary. If the AmbT sensor or the Pres sensor require calibration (an adjustment), then the flow must also be verified and probably recalibrated.

AJ.2.0.3 APPARATUS FOR R&P PM-2.5 FRM SINGLE-CHANNEL SAMPLER CALIBRATION

1. Certified mass flow transfer standard.
2. Certified reference temperature meter.
3. Certified pressure meter.
4. R&P inlet flow audit adapter.
5. Tubing (tygon or surgical type).
6. Blank filter.
7. Calibration forms and/or laptop computer.
8. Digital volt meter (DVM).
9. Optional: R&P FTS Streamline 0-20 L/min fixed orifice calibration kit.

AJ.2.0.4 CALIBRATION OUTLINE

1. Verify flow.
2. Leak check.
3. Verify/calibrate interface board.
4. Verify/calibrate Analog input (A/I).
5. Verify/calibrate AmbT (+/- 2 ^{0}C).
6. Verify/calibrate FltT (+/- 2 ^{0}C).
7. Verify/calibrate Pres (+/- 10mm Hg).
8. Calibrate flow.
9. Verify calibrated flow (+/- 2% of 16.7 LPM; 16.4 - 17.0 LPM).

NOTE: Routine calibration will skip steps 3 & 4 above.

California Air Resources Board
R&P PM2.5 FRM Single Channel Sampler
Calibration Datasheet

Site Name _____ Site Number _____ Sampler Property Number _____
Site Elevation _____ Ambient Temperature _____ Ambient Pressure _____

Temperature Sensor Calibration

Temperature Standard ID Number _____ Certification Date _____
Ambient Temperature Sensor: Ambient Reading _____ Span _____ Offset _____
Filter Temperature Sensor: Ambient Reading _____ Span _____ Offset _____

Pressure Sensor Calibration

Pressure Standard ID Number _____ Certification Date _____
Standard Slope _____ Standard Intercept _____
Barometric Pressure _____ Span _____ Offset _____

Leak Test

External Leak Flow _____ Time _____
Internal Leak Flow _____ Time _____

Flow Calibration

MFM Standard ID Number _____ Certification Date _____
Standard Slope _____ Standard Intercept _____

Nominal Flow	Sampler Flow	Standard Flow	Temperature
16.7			
17.5			
15.8			
18.3			
15.0			

Sampler Span _____ Offset _____
Calibrated by _____ Checked by _____

Temperature Calibration Verification

Temperature Standard ID Number _____ Certification Date _____
Ambient Temperature Sensor: Ambient Reading _____ Span _____ Offset _____
Filter Temperature Sensor: Ambient Reading _____ Span _____ Offset _____

Pressure Verification

Sampler Pressure _____ Pressure Standard _____

Flow Verification

Sampler Flow _____ MFM Standard Flow: Qstd _____ Qact _____
Percent Difference _____

Time Verification

Time Standard Make _____ Model _____ Certification Date _____ Bias _____
Sampler Time _____ Time Standard Time _____ Difference _____

Final Time Set

Sampler Time _____ Time Standard Time _____ Difference _____
Calibrated by _____ Checked by _____

Figure AJ.2.0.1
R&P PM-2.5 FRM Single-Channel Calibration Datasheet

AJ.2.1 CALIBRATION PROCEDURES

AJ.2.1.1 AS-IS FLOW CHECK

The "as-is" flow verification is the first step for routine calibration of the R&P 2000 (initial sampler setup does not require an as-is flow verification since a full instrument calibration is required). The as-is flow check procedure (R&P manual, Section 10.2.6) is performed to verify the working status of the sampler by ensuring that the calculated true flow at the inlet of the sampler is +/- 2% of 16.7 LPM. If the calculated true flow of the sampler is between 16.4 - 17.0 LPM, flow calibration is not necessary unless any subsequent sensor or electronic board adjustments alter the flow. There are two methods to verify and calibrate flow. The first method measures flow directly with a mass flow meter (MFM); the second method uses the Streamline Flow Transfer Standard (FTS) which measures a pressure differential. Both MFM and FTS data must be corrected to true flow using temperature and pressure data.

1. AS-IS FLOW CHECK USING MFM:

   The MFM procedure is the method of choice for verifying inlet flow because the MFM method measures flow directly. The following procedure describes how to verify flow with a certified MFM.

   a. Carefully remove and replace the 1st stage inlet impactor with the flow audit adaptor and open the stop cock valve.

   b. Connect the flow inlet adaptor to the MFM.

   c. Start in the main screen by pressing <**ESC**> if necessary and make sure that the sampler is in the "stop" operating mode by pressing <**F4: Run/Stp**> until "stop" is displayed in the upper right hand corner.

   d. Install a filter cassette containing a 47mm filter into filter holding mechanism.

   e. Press <**F5: Setup**>, then <**F5: Audit**>, then <**F2: Valve**> and then <**F3: Pump**>.

   f. Allow the sampler flow and MFM reading to stabilize and record the measured flow reading.

g. Calculate true flow from the measured flow reading and determine the percent difference from 16.7 LPM. The equation used for calculating true flow is:

$$\text{Volumetric flow} = \frac{(\text{std. flow})(760\text{ mm Hg})(\text{ambient temp in K})}{(\text{ambient pressure in mm Hg})(298\text{ K})}$$

NOTE: The equation for standard flow used above is:

std. Flow = [(MFM disp)(MFM cert. Slope)] + (MFM cert. Intercept)

h. If the calculated true flow differs more than +/- 2% of 16.7 LPM, the R&P 2000 sampler flow must be recalibrated. If the flow is out of range or unstable, it may be possible that a leak is the cause. Check your flow check equipment to make sure the they are not at fault. The calculation for % difference is:

$$\frac{(\text{True flow} - 16.7)}{16.7} \times 100\%$$

NOTE: When finished, press <ESC> twice to return to main screen.

2 AS-IS FLOW CHECK USING FTS:

The FTS method is the secondary method of choice when used for measuring inlet flow because the FTS measures a pressure differential and must be converted to flow units. The FTS is an accurate device and appears to work well when used as a calibration tool, but when possible, the primary choice for verifying flow should be a flow measuring device. The following procedure describes how to use the FTS as a flow check device.

a. Carefully remove and replace the 1st stage inlet impactor with the FTS fixed orifice (the fixed orifice should be connected to the minus (-) port of the digital flow manometer by the supplied piece of black rubber tubing).

b. Start in the main screen by pressing <**ESC**> if necessary and make sure that the sampler is in the "stop" operating mode by pressing <**F4:**

Run/Stp> until "stop" is displayed in the upper right hand corner.

c. Install a filter cassette containing a 47mm filter into filter holding mechanism.

d. With the digital manometer turned on and in "measuring in inches of water", adjust the silver colored knob at the top of the manometer (located between the + and - ports), until a reading of 0.00" H_2O is reached (zeroing the manometer).

e. Press <**F5: Setup**>, then <**F5: Audit**>, then <**F2: Valve**> and then <**F3: Pump**>.

f. Allow the sampler flow and FTS reading to stabilize and record the measured pressure reading.

g. Calculate true flow from the measured FTS reading and determine the percent difference from 16.7 LPM. The true flow conversion equation, orifice slope and intercept used for calculating true flow is located on the fixed orifice and included below:

$$\text{True flow} = \left[(\text{orifice m})\left(\frac{\text{FTS P x AmbT K}}{\text{AmbP atm}}\right)^{0.5}\right] + (\text{orifice b})$$

Where: orifice m = orifice slope
orifice b = orifice intercept
FTS P = FTS differential pressure reading in inches of water
AmbT K = ambient temperature in Kelvin
(273 K + ambient ^{O}C)
AmbP = ambient pressure in atmospheres =ambient pressure in mmHg/760mmHg
(1 atm. = 760 mm Hg amb/760 mm Hg)

h. If the calculated true flow differs more than +/- 2% of 16.7 LPM, the R&P 2000 sampler flow must be recalibrated. If the flow is out of range or unstable, it may be possible that a leak is the cause. Check your flow check equipment to make sure that they are not at fault.

NOTE: When finished, press <ESC> twice to return to main screen.

AJ.2.1.2 LEAK CHECK

The next step is to perform an internal leak check (R&P manual, Section 10.2.4) on the sampler. The leak check procedure is performed to determine if leaks in the sampler exist and to ensure correct installation of the flow measuring equipment. If the following leak check fails, locate and remedy the problem, then go back and re-verify the flow.

1. Carefully remove and replace the 1st stage inlet impactor with the supplied flow audit adaptor and the stop cock valve open.

2. Start in the main screen by pressing <**ESC**> if necessary and make sure that the sampler is in the "stop" operating mode by pressing <**F4: Run/Stp**> until "stop" is displayed in the upper right hand corner.

3. Install a filter cassette containing a 47mm filter into filter holding mechanism.

4. Press <**F5: Setup**>, then <**F5: Audit**>, then <**F2: Valve**> and then <**F3: Pump**>.

5. Close the stop cock valve on the audit flow adaptor and read the vacuum gauge immediately (the vacuum gauge is located behind the small hinged door below the opening of the filter holding mechanism).

6. Within 30 seconds, the vacuum gauge should hold at or above 8.5 in. of Hg. If the vacuum gauge indicates a value less than 8.5 in. of Hg during this 30 second period, locate the leak, fix and re-check.

7. When finished, press <**ESC**> twice to return to main screen.

AJ.2.1.3 INTERFACE BOARD VERIFICATION/CALIBRATION

When installing or replacing an R&P 2000, the interface electronics board (I board) should be checked and adjusted as needed (R&P manual, section 11.1). The following procedure describes how to check and adjust the I board.

1. Locate the I board. The I board is located on the bottom of the electronics compartment. Access the compartment by removing the three screws on the hinged door located above the front digital display.

2. Sampler must be turned on and in the "stop" operation mode.

3. The digital display backlight must be on (pressing any key on the keypad, such as the <**ESC**> key, will turn on the backlight).

4. Locate the red 2.5 V, 6 V, 10 V and black GND test points and the adjustable pots labeled R21, R44 and R53 on the I board (refer to Figure AJ.2.1.1 for locations).

5. Place the positive lead of the DVM on the 6 V test point and the negative lead on the GND test point. Read and record the output.

6. If needed, adjust pot R21 on the I board until the DVM reads 6.0 VDC +/- 0.05 V.

7. Next, place the DVM positive lead on the 2.5 V test point, read, record and adjust pot R53 until the DVM reads 2.5 VDC +/- 0.002 V.

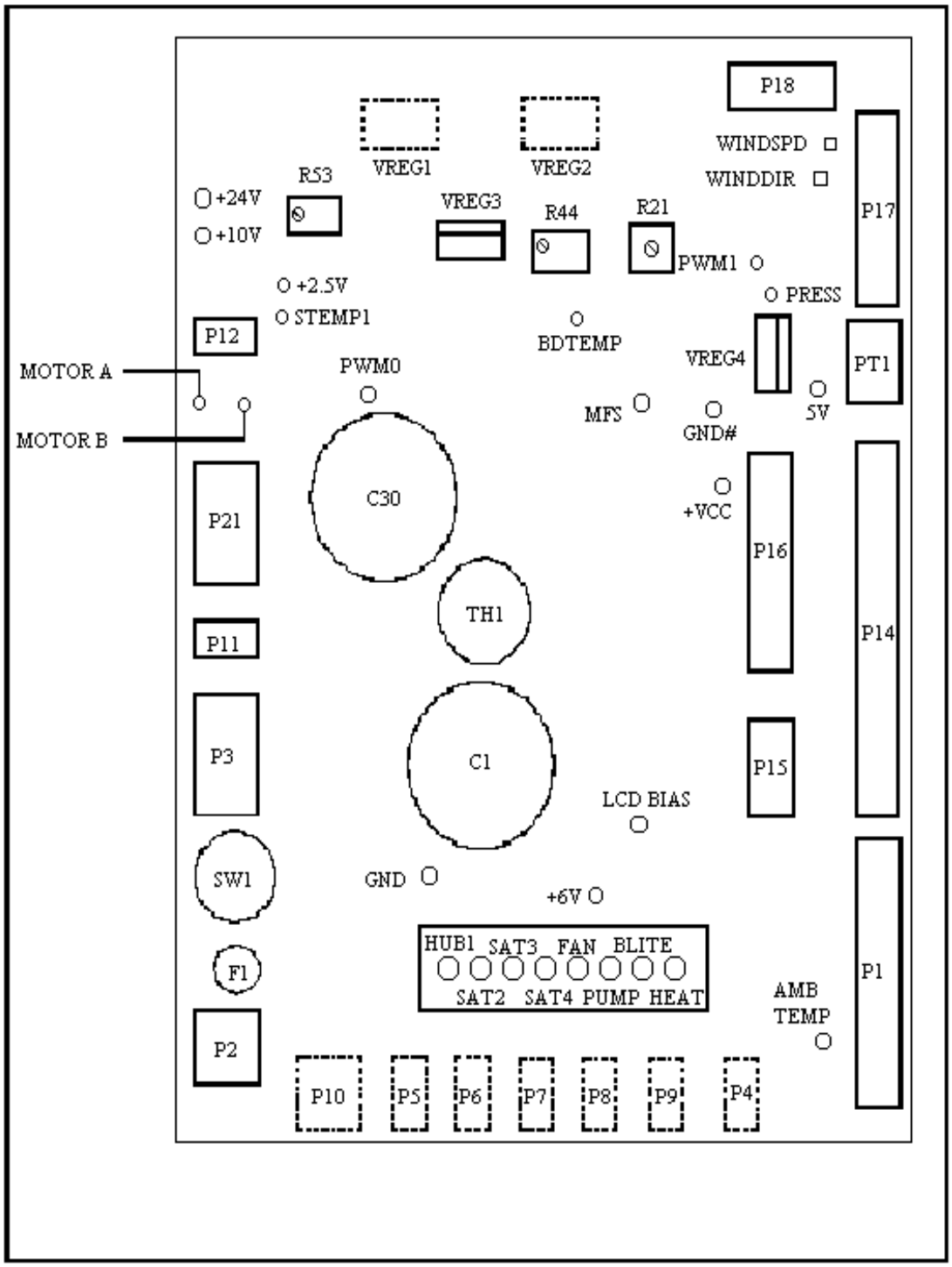

Figure AJ.2.1.1
Layout of Interface Board

8. Now, place the DVM positive lead on the 10 V test point, read, record and adjust pot R44 until the DVM reads 10 VDC +/- 0.002 V.

9. Leave the electronics compartment door open to calibrate the analog input (A/I) board in the following section (AJ.2.1.4)

10. The I board calibration is now complete and should only need checking and calibration when the sampler is moved or when troubleshooting.

AJ.2.1.4 ANALOG INPUT (A/I) VERIFICATION/CALIBRATION

After checking/calibrating the I board, the A/I board must be checked and calibrated as needed (R&P manual section 11.2).

1. Push the <**ESC**> key on the keypad until returned to main screen and ensure that the sampler is in the "stop" operating mode.

2. Locate and unplug the connector cable labeled P18 at the back of the I board by gently pulling the thin brown plastic strap on top of the plug forward (refer to Figure AJ.2.1.1 for location).

3. Plug in the analog adaptor plug into P18 (adaptor plug is provided with the sampler, R&P p/n 51-004282).

4. Place the DVM positive lead on the green test point labeled PWMI, and the DVM negative lead on the test point labeled GND.

5. Press <**F5: Setup**>, then <**F2: Calib**> and then <**F1: Edit**>.

6. Move the cursor over to the right hand side of the screen to the row labeled "A/O".

7. Choose and enter a value between 0.050 and 0.150 V (i.e. 0.100 V).

8. Observe the number displayed in the column labeled "calc" on the row labeled "A/I". This number should not vary more than +/- 0.005 V (from itself) after watching for 5 seconds. If this number is not stable, choose and enter another value between 0.050 and 0.150 V until the number displayed becomes stable.

9. With the DVM in place, read the DVM display.

10. Press <**F1: EDIT**> and using the arrow keys, move the cursor to the column labeled "Act" in the row labeled A/I.

11. Enter the DVM reading to three decimals (a.bcd) and press <**ENTER**> (this calculates offset).

12. The number in the "calc" column should match the number on the DVM +/- 0.005 V.

13. Press <**F1: EDIT**> again and move the cursor back over to the right hand side of the screen to the row labeled "A/O".

14. Choose and enter in a number between 4.800 and 4.900 V (i.e. 4.850 VDC) and press <**ENTER**>.

15. Observe again the number displayed in the column labeled "calc" in the row labeled "A/I". This should not vary more than +/- 0.005 V (from itself) after watching it for 5 seconds (if this number is unstable, choose another number for "A/O" between 4.800 and 4.900 V until stable).

16. Press <**F1: EDIT**> and using the arrow keys, move the cursor to the column labeled "Act" in the row labeled "A/I".

17. Type in the DVM reading to three decimals and press <**ENTER**> (this calculates span). The number now displayed on the DVM should match the number in the column labeled "calc" within +/- 0.005 V.

18. Remove the adaptor plug and re-connect the cable in location P18.

19. The A/I calibration is now complete and should only need checking and calibration when sampler is moved, when troubleshooting or when the interface board is calibrated.

The R&P single channel PM2.5 FRM sampler has two temperature sensors: the ambient and the filter sensors. These two temperature sensors require one temperature data point each to calibrate. The following procedure requires an external certified thermometer.

1. AMBIENT TEMPERATURE CHECK/CALIBRATION:

The following procedures are found in the R&P manual, section 11.3.

a. AS-IS AMBIENT TEMPERATURE CHECK:

1) Remove the ambient temperature thermocouple from the external housing.

2) Place the thermocouple and the external thermometer in a similar medium if possible (i.e. packing material). The main point is to place them in as similar an environment as possible.

3) Record and compare sensor and external thermometer readings. The sensor reading must be within 2^{O}C of the external thermometer temperature.

4) If the ambient temperature sensor fails the ambient temperature check, the sensor will need to be calibrated.

b. AMBIENT TEMPERATURE CALIBRATION:

1) To calibrate the ambient temperature sensor, start in the main screen and ensure that sampler is in the “stop” operation mode.

2) Press <**F5: Setup**>, then <**F2: Calib**> and then <**F1: Edit**>.

3) Using the arrow keys, move cursor to the “Act” column in the row labeled “AmbT”.

4) Enter the current temperature as displayed on the external thermometer device (press <**SHIFT**><**F1**> to enter a negative number).

5) Press <**ENTER**> and record the offset number listed under the column labeled “offset”.

2. FILTER TEMPERATURE CALIBRATION:

The following procedures are found in the R&P manual, Section 11.4.

a. FILTER TEMPERATURE CHECK:

1) The filter sensor is located directly beneath the filter cassette. Open the filter exchange mechanism by pulling on the foam padded handle and remove the filter cassette if present.

2) Place the external thermometer sensor next to the filter sensor so that they share the same environment.

3) Record and compare sensor and external thermometer readings. The sensor reading must be within 2^{O}C of the external thermometer temperature.

4) If the filter temperature sensor fails the ambient temperature check, the sensor will need to be calibrated.

b. FILTER TEMPERATURE CALIBRATION:

1) To calibrate the filter temperature sensor, start in the main screen and ensure that sampler is in the “stop” operation mode.

2) Press <**F5: Setup**>, then <**F2: Calib**> and then <**F1: Edit**>.

3) Using the arrow keys, move cursor to the “Act” column in the row labeled “FltT”.

4) Enter the current temperature as displayed on the external thermometer device (press <**SHIFT**><**F1**> to enter a negative number).

5) Press <**ENTER**> and record the offset number located in the column labeled “offset”.

AJ.2.1.6 AMBIENT PRESSURE CALIBRATION

The ambient pressure calibration (R&P manual, section 11.5) will require a certified pressure sensor.

1. Return the sampler to the Main Screen and make sure that the sampler is in the "stop" operation mode.

2. Compare the displayed R&P 2000 pressure reading to the pressure of the certified pressure sensor. The sampler pressure reading should be within 10 mm Hg of the pressure measuring device. If not, then proceed to calibrate.

3. Press <**F5: Setup**>, then <**F2: Calib**> and then <**F1: Edit**>.

4. Determine the current ambient pressure in mm Hg.

5. Using the arrow keys, move the cursor to "Act" column in the row labeled "Pres".

6. Enter the current ambient pressure in mm Hg and press <**ENTER**>.

7. Record the offset number located in the column labeled "offset".

AJ.2.1.7 FLOW CALIBRATION

To calibrate flow (R&P manual, section 11.6.2) a minimum of three points are required. The R&P 2000 flow calibration is software driven and offers the option of a one-point or a five-point calibration. Due to U.S. EPA requirements, we will be calibrating the R&P 2000 by performing the five-point flow calibration procedure. The mass flow controller of the R&P 2000 can be calibrated using a mass flow meter (MFM) or the Streamline FTS. When using the MFM, flow input data must be converted from standard flow to true flow using temperature and pressure data. When using the Streamline FTS, there are no external data conversions. Both procedures are described below.

1. FLOW CALIBRATION USING MFM:

    a. Return to the Main Screen and make sure that the sampler is in the "stop" operating mode (by press <**F4: Run/Stp**> if needed).

    b. Carefully remove the 1st stage inlet from sampler.

c. Carefully install the flow audit adaptor and turn the stopcock valve to the open position.

d. Install a filter cassette containing a 47mm filter into filter holding mechanism.

e. Attach the audit flow adaptor to the MFM.

f. Press <**F5: Setup**>, then <**F2: Calib**>, then <**F2: FlowCal**>, and then <**F2: Start**>.

g. After a few moments, the flow pump will start. Allow the pump to run for a few minutes until both the MFM and the sampler flow display produce a stable reading. At this point, enter the true flow calculated from the MFM reading into the column labeled "Flow"and press enter. Again, the equation for calculating true flow is:

$$\text{Volumetric flow} = \frac{(\text{std. flow})(760\text{ mm Hg})(\text{ambient temp in K})}{(\text{ambient pressure in mm Hg})(298\text{ K})}$$

NOTE: The equation for standard flow used above is:

$$\text{std. flow} = [(\text{MFM disp})(\text{MFM cert. slope})] + (\text{MFM cert. intercept})$$

h. The sampler will compute span and automatically change the inlet flow for the next point.

i. Repeat step 7, until the fifth flow point is entered. When the last point is entered, the sampler will automatically shut off.

j. Record the offset and span value.

k. Now that the sampler is calibrated, return to the main menu by pressing the <**ESC**> key three times.

2. FLOW CALIBRATION USING FTS:

The Streamline FTS calibration procedure is similar to the MFM procedure except that the measured data is collected in terms of inches of water in lieu of

LPM and that manometer readings do not require external conversion.

a. Return to the Main Screen and make sure that the sampler is in the "stop" operating mode (by pressing <**F4: Run/Stp**> if needed).

b. Carefully remove the 1st stage inlet from sampler.

c. Carefully connect the FTS fixed orifice to the inlet of the R&P 2000 (the fixed orifice should be connected to the minus (-) port of the digital flow manometer by the supplied piece of black rubber tubing).

d. Install a filter cassette containing a 47mm filter into filter holding mechanism.

e. Enter in the slope and offset values listed on the fixed orifice by pressing <**F5: Setup**> and then <**F1: Edit**>. Arrow down to the "FTS Const M" row, type in the slope of the fixed orifice and press <**ENTER**>. Press <**F1: Edit**> again, arrow down to the "FTS Const B" row, type in the intercept of the fixed orifice and press <**ENTER**>.

f. Press <**ESC**> until back into the main screen.

g. To start the calibration, press <**F5: Setup**>, then <**F2: Calib**>, then <**F2: FlowCal**>, and then <**F2: Start**>.

h. After a few moments, the flow pump will start. Allow the pump to run for a few minutes until both the FTS and the sampler flow display read a stable value. At this point, enter the manometer reading in inches of water into the column labeled "FTS" and press enter.

i. The sampler will compute span and automatically change inlet flow for the next point.

j. Allow flow to stabilize for a few minutes and enter the next manometer reading.

k. Repeat steps 8 through 10 until the fifth flow point is entered. When the last point is entered, the sampler will automatically shut off.

l. Record the offset and span value.

m. Now that the sampler is calibrated, return to the main menu by pressing the <**ESC**> key three times.

AJ.2.1.8 VERIFICATION OF CALIBRATED FLOW

The procedure used to verify the sampler flow rate after calibration is identical to the flow check procedure described above (section AJ.2.1.1) for both the mass flow meter (MFM) and pressure drop (FTS) methods. This post calibration flow check is essential to verify the accuracy of the sampler flow. Record the final flow value.

NOTE: Monthly checks will be performed by the station operator. If flow abnormalities appear, the inlet flow should be checked using a MFM in which the resultant calculated true flow is within 4% of 16.7 LPM.